



Consistency of CERES radiances and fluxes from Aqua and Suomi-NPP

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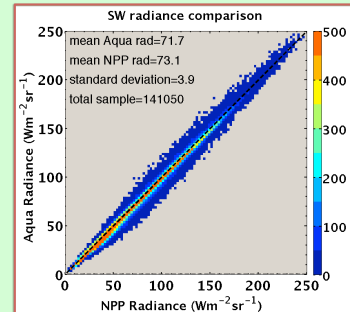
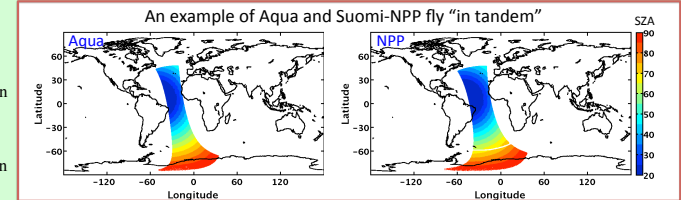
Background

- The Clouds and the Earth's Radiant Energy System (CERES) instruments are on board both Aqua and Suomi-NPP.
- The CERES instrument measures radiances in shortwave (SW, 0.3-5 μm), window (WN, 8-12 μm), and total (0.3-200 μm) channels. The longwave (LW) component is derived as the difference between total and SW channels.
- These measured radiances at a given sun-Earth-satellite geometry are converted to outgoing reflected solar and emitted thermal radiative fluxes by using CERES scene-type dependent angular distribution models (ADMs). Aqua ADMs are used to invert fluxes for CERES instruments on Suomi-NPP.
- The CERES instruments must remain radiometrically stable and correctly inter-calibrated to accurately capture changes in Earth's radiation budget from interannual to decadal timescales.

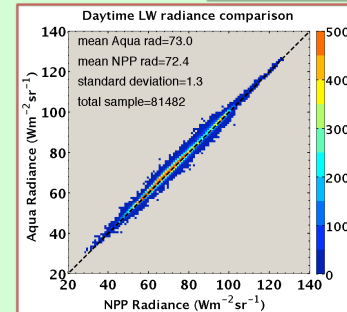
	Aqua	Suomi-NPP
Launch date	May 4, 2002	Oct. 28, 2011
Altitude	705 km	824 km
Inclination	98.14°	98.75°
Period	98.4 min	101.4 min
CERES footprint size	20 km at nadir	24 km at nadir
Imager	MODIS	VIIRS

Radiance comparison using simultaneous observations

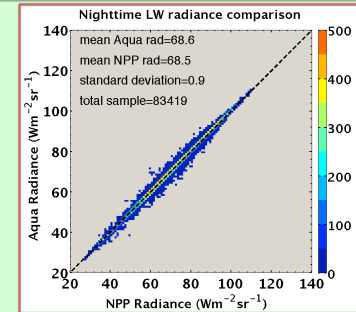
- About every 64 hours, Aqua and Suomi-NPP fly "in tandem".
- These simultaneous observations from Aqua and Suomi-NPP are matched to compare SW and LW radiances using CERES SSF data of 2012 and 2013.
- Matching criteria used for SW radiances are: latitude and longitude differences are less than 0.05 degree, solar zenith angle difference is less than 2 degrees, viewing zenith angle and relative azimuth angle differences are less than 5 degrees.
- Matching criteria used for LW radiances are: latitude and longitude differences are less than 0.05 degree, and viewing zenith angle difference is less than 2 degrees.



The SW radiance from Suomi-NPP is about 2% higher than that from Aqua.



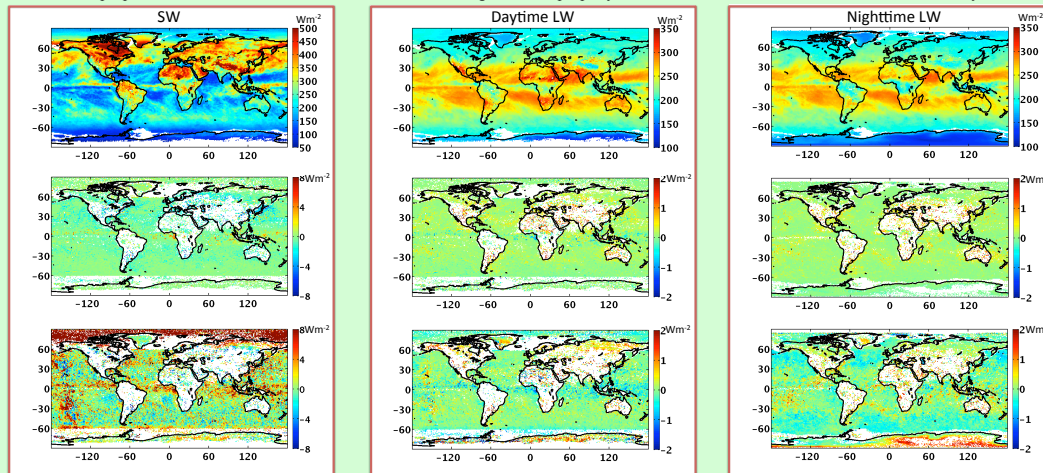
The daytime LW radiance from Suomi-NPP is about 0.8% lower than that from Aqua.



The nighttime LW radiance from Suomi-NPP is about 0.1% lower than that from Aqua.

Quantify flux error caused by different footprint size and cloud properties

- Simulate Aqua and Suomi-NPP footprints using MODIS pixel data.
- Derive broadband radiances for these simulated Aqua and Suomi-NPP footprints using MODIS spectral channels.
- Convert the broadband radiances to fluxes using Aqua ADMs and scene identification from MODIS.
- Perturb cloud properties retrieved from MODIS to be VIIRS-like using the cloud property ratios between MODIS and VIIRS for each cloud layer.



The top row figures show the monthly gridded mean SW (left), daytime LW (middle), and nighttime LW (right) fluxes derived using simulated Aqua footprints. The middle row figures show the flux differences caused by footprint size difference between Suomi-NPP and Aqua, and the bottom row figures show the flux differences caused by both footprint size and cloud property differences.

Discussions

- CERES shortwave radiances from Suomi-NPP are about 2% higher than those from Aqua.
- CERES daytime longwave radiances from Suomi-NPP are about 0.8% lower than those from Aqua. CERES nighttime longwave radiances from Suomi-NPP and Aqua agree very well.
- Studies using simulated Aqua and Suomi-NPP footprints indicate that footprint size difference between CERES instruments on Aqua and on Suomi-NPP introduces mean absolute errors of 0.8 Wm^{-2} , 0.2 Wm^{-2} , and 0.1 Wm^{-2} for SW, daytime LW, and nighttime LW fluxes on a global monthly basis.
- The mean absolute errors increase to 4.3 Wm^{-2} , 0.4 Wm^{-2} , and 0.4 Wm^{-2} for SW, daytime LW, and nighttime LW fluxes after we take the cloud property retrieval differences between MODIS and VIIRS into consideration. Regional SW errors greater than 20 Wm^{-2} and LW errors greater than 3 Wm^{-2} are observed over polar regions.

Future work

- Calibrate CERES instrument on Suomi-NPP to be on the same radiometric scale as CERES instrument on Aqua.
- Quantify CERES Suomi-NPP flux errors caused by using CERES Aqua ADMs and the cloud property differences between MODIS and VIIRS.